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(54) **DETECTION APPARATUS FOR LIGHT-EMITTING DIODE CHIP**

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G01R 31/44	(2006.01)
G01R 31/26	(2014.01)
G01J 1/42	(2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
CPC G01J 2001/4252; G01J 2001/4247; G01R 31/2635
USPC 356/213, 218
See application file for complete search history.

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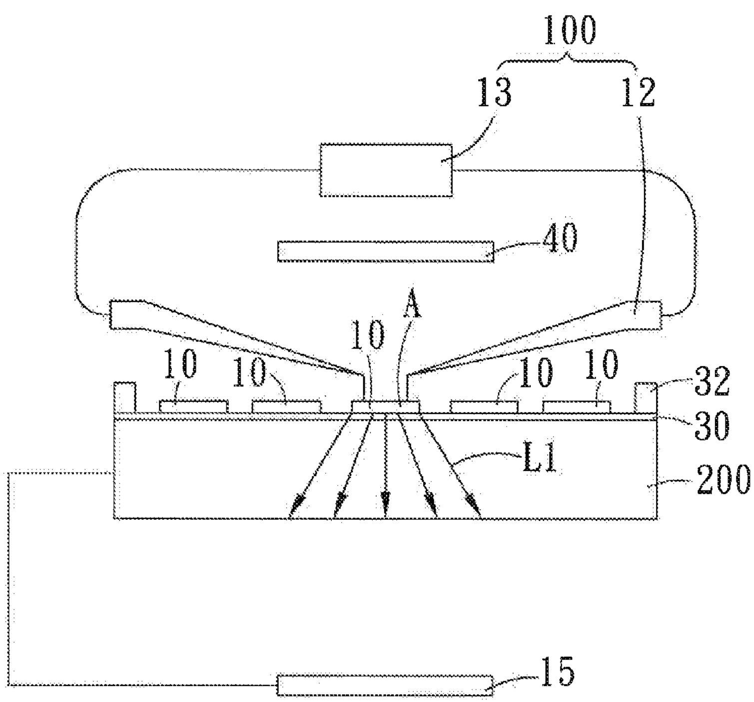
(57) **ABSTRACT**

A detection apparatus for light-emitting diode chip comprising a substrate with the function of photoelectric conversion and a probing device is disclosed. The substrate is designed to bear at least one light-emitting diode chip. The probing device comprises a power supply and at least two conductive elements. The two ends of the conductive elements are respectively electrically connected to the light-emitting diode chip and the power supply to enable the light-emitting diode chip to emit light beams. Some of the light beams are emitted from the light-emitting diode chip toward the substrate such that the light beams emitted by the light-emitting diode chip are converted into an electric signal by the substrate.

13 Claims, 3 Drawing Sheets



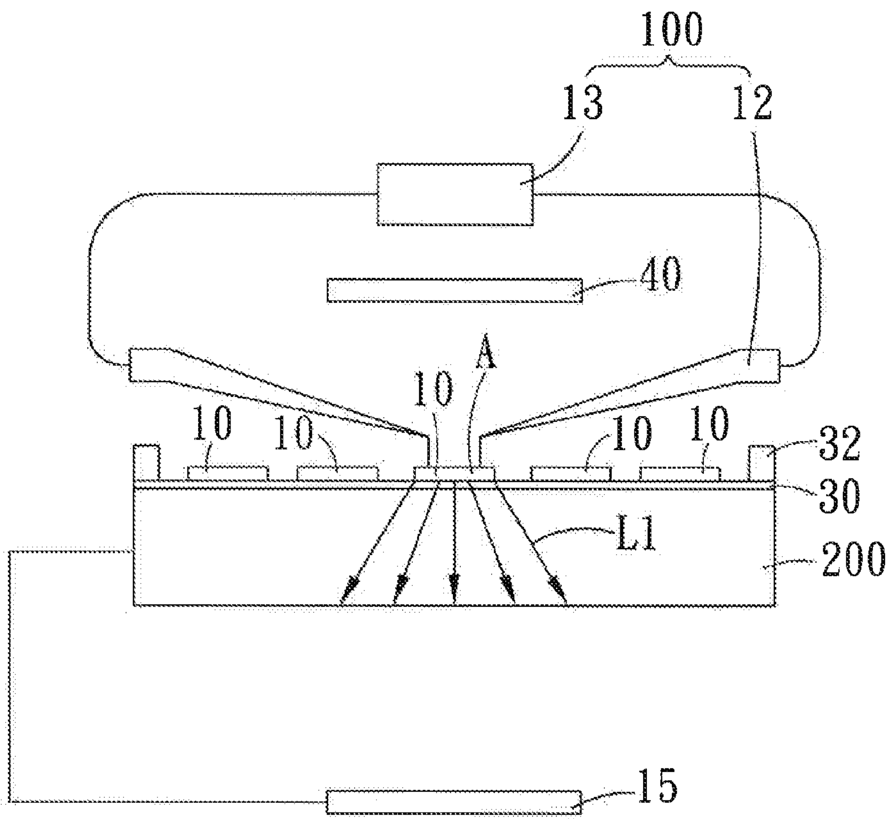


FIG. 1

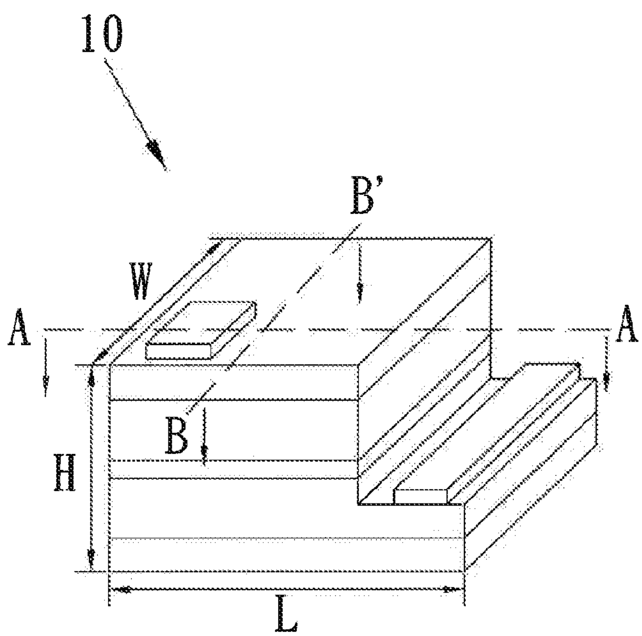


FIG. 2A

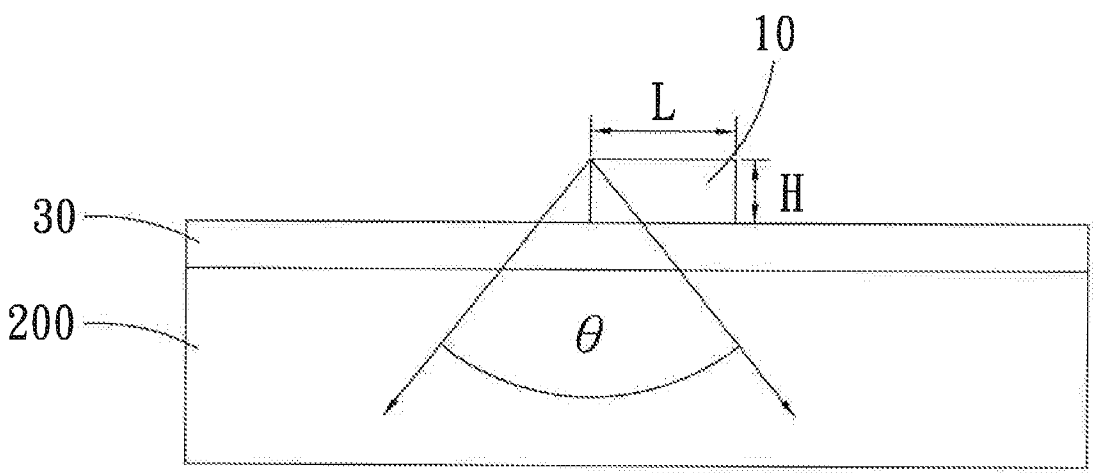


FIG. 2B

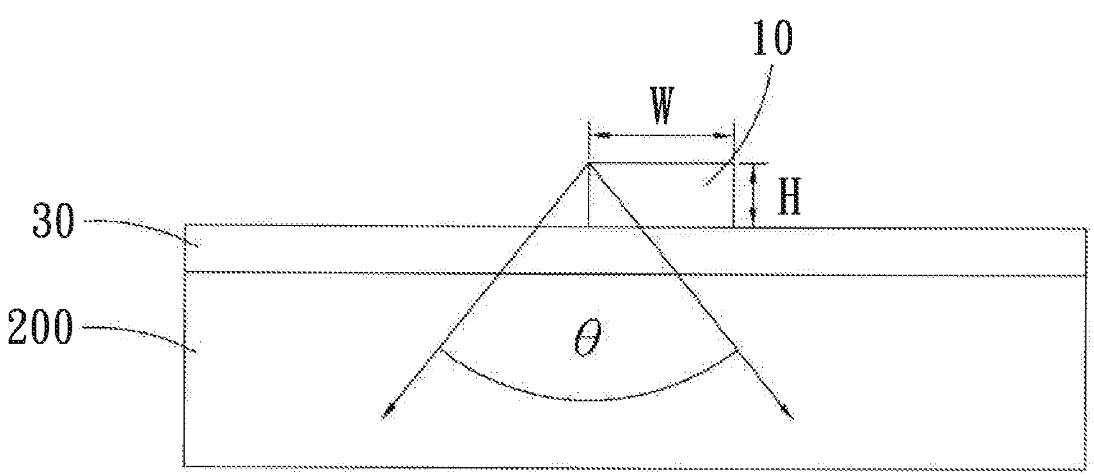


FIG. 2C

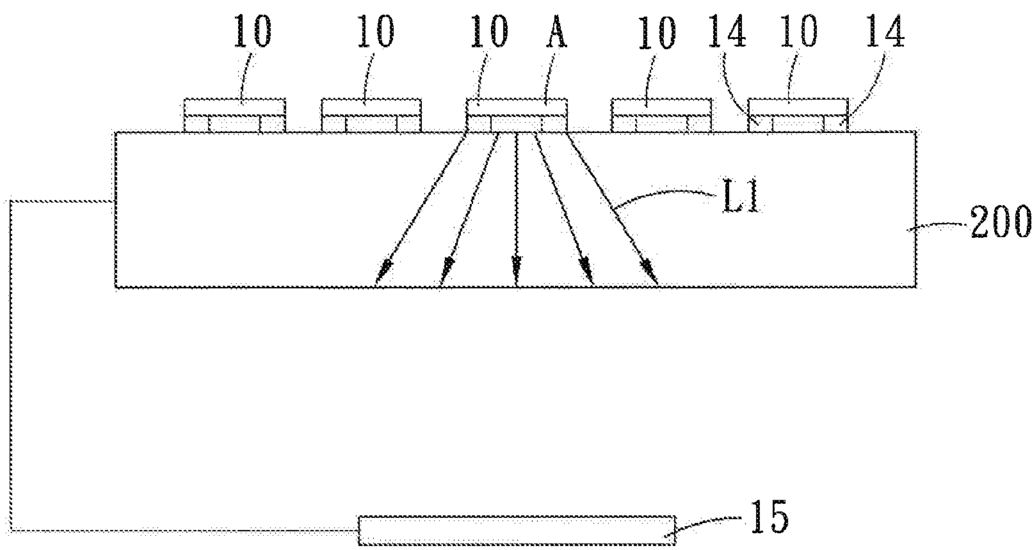


FIG. 3

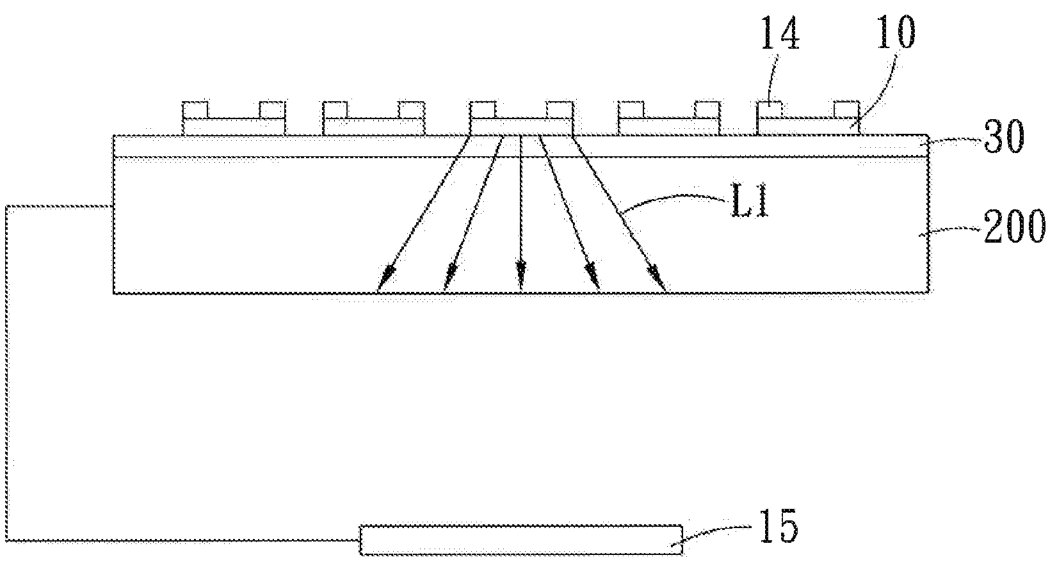


FIG. 4

DETECTION APPARATUS FOR LIGHT-EMITTING DIODE CHIP

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Taiwan Patent Application No. 101146326, filed on Dec. 10, 2012, the contents of which are hereby incorporated by reference in their entirety for all purposes.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a detection apparatus, and particularly, to a detection apparatus for detecting a light-emitting diode chip.

2. Description of the Related Art

Due to the technology improvements and the elevation of life quality, modern people pay more and more attention to illumination. From the ancient illumination measures of burning material, such as fire torches, vegetable oil lamps, candles, and kerosene lamps, of using electricity, such as incandescent lamps and fluorescent lamps, to the modern light-emitting diode (LED), it all shows that illumination plays an important role in people's ordinary life.

By combining the electrons and electronic holes, light-emitting diode emits light to provide illumination or alerting. Compared with the traditional light sources, the light-emitting diode has the advantages of high light-emitting efficiency, long service life, robust, fast response time, etc. In recent years, due to the great promotion of governments and the increasing scale of the light-emitting diode street lamps in cities, using light-emitting diode as the illumination source is available everywhere.

Generally, a probe device is used to test the luminous efficiency of the light-emitting diode chips. The probe device provides a power source through the probe pins to enable a light-emitting diode chip to emit light beams, and the light beams are then collected by a light-sensing device of the probe device such that the luminous efficiency of the light-emitting diode chip could be determined. However, when using the probe device, the complication and the detection time of detecting the light-emitting diode chip are increased because user has to select an appropriate light-sensing device to detect the luminous efficiency of the light-emitting diode chip, and in practically operated, user has to adjust the opposite position between the light-sensing device and the light-emitting diode chip to achieve the object of collecting light completely. Besides, the light loss would be caused owing to the light refraction of the pathway of the light beams passing from the chuck to the light-sensing device such that the accuracy of detecting the luminous efficiency of the light-emitting diode chip is influenced.

SUMMARY OF THE INVENTION

In view of the foregoing problems of the prior arts, one of the objects of the present invention is to provide a detection apparatus for light-emitting diode chip to reduce the complication and the detection time of detecting the light-emitting diode chip.

According to another object of the present invention, the present invention provides a detection apparatus for light-emitting diode chip to increase the accuracy of detecting the light-emitting diode chip.

To fulfill the aforementioned objects, the present invention provides a detection apparatus for light-emitting diode chip, which comprises a substrate with the function of photoelectric conversion and a probing device. The substrate is designed to bear at least one light-emitting diode chip. The probing device comprises a power supply and at least two conductive elements, and two ends of the conductive elements are respectively electrically connected to the light-emitting diode chip and the power supply to enable the light-emitting diode chip to emit light beams. Additionally, some of the light beams are emitted from the light-emitting diode chip toward the substrate such that the light beams emitted by the light-emitting diode chip are converted into an electric signal by the substrate. Wherein the substrate is a solar panel or a photodetector array, and the solar panel is an amorphous solar panel or a III-V solar panel, and the photodetector array is an array of photoelectric diodes, charge coupled devices (CCDs), light dependent resistances, quantum optical detectors, photoelectric gates, phototransistors, or photoconductors.

Additionally, the area of the substrate is substantially larger than the light-emitting diode chips or the array distribution area of the light-emitting diode chips. Preferably, the area of the substrate is larger than $[(L+2H \tan(\theta/2)] \times [W+2H \tan(\theta/2)]$, wherein L is the length of the light-emitting diode chip, W is the width of the light-emitting diode chip, H is the height of the light-emitting diode chip, and θ is the biggest light-emitting angle of the light-emitting diode chip toward the substrate.

According to the first preferred embodiment of the present invention, the conductive elements are probe pins.

According to the second preferred embodiment of the present invention, the conductive elements are conductive films, and the conductive films are disposed between the substrate and the light-emitting diode chip. Wherein, the material of the conductive films is indium tin oxide (ITO) or indium zinc oxide (IZO).

According to the third preferred embodiment of the present invention, the conductive elements are conductive films, and the conductive films are disposed over the substrate and the light-emitting diode chip. Wherein, the material of the conductive films is indium tin oxide (ITO) or indium zinc oxide (IZO).

In the first and the third preferred embodiment of the present invention, a film with adhesive property is disposed between the substrate and the light-emitting diode chip, and a grip ring is further disposed on the film to expand the film.

Additionally, in the first, the second, and the third preferred embodiments of the present invention, a reflective film could be disposed on one side of the light-emitting diode chip opposite to the substrate to reflect the light beams or the lateral light beams of the light-emitting diode chip opposite to the substrate. Wherein, the reflective film is a film with reflective index larger than 90% within a range of light wavelength from 300 nm to 700 nm. Preferably, the reflective film is a film with reflective index larger than 90% within a range of visible blue light from 430 nm to 475 nm.

As above-mentioned, the detection apparatus for light-emitting diode chip of the present invention may have one or more characteristics and advantages as described below:

(1) In the detection apparatus for light-emitting diode chip of the present invention, the complication of operating the detection apparatus and the detection time of detecting the light-emitting diode chip are reduced by using the substrate with the function of photoelectric conversion to bear light-emitting diode chip and to detect the luminous efficiency thereof.

(2) In the detection apparatus for light-emitting diode chip of the present invention, the light loss is reduced and the accuracy of detecting the light-emitting diode chip is increased by using the substrate with the function of photoelectric conversion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic sectional view showing a detection apparatus for a light-emitting diode chip according to a first preferred embodiment of the present invention;

FIG. **2**A is a stereoscopic diagram of the light-emitting diode chip;

FIG. **2**B is a schematic sectional view of the light-emitting diode chip taken along a section line A-A' of FIG. **2**A;

FIG. **2**C is a schematic sectional view of the light-emitting diode chip taken along a section line B-B' of FIG. **2**A;

FIG. **3** is a schematic sectional view showing the detection apparatus for light-emitting diode chip according to a second preferred embodiment of the present invention; and

FIG. **4** is a schematic sectional view showing the detection apparatus for light-emitting diode chip according to a third preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The detection apparatus for light-emitting diode chip of the present invention comprises a substrate with the function of photoelectric conversion and a probing device. Wherein, the probing device comprises a power supply and at least two conductive elements. In the embodiments of the present invention, the conductive elements can be, for example, probe pins or conductive films. User could selectively use the probe pins or the conductive films for practical demand to electrically contact to the light-emitting diode chip and provide the light-emitting diode chip with a voltage. However, in the detection apparatus for light-emitting diode chip of the present invention, the conductive elements would not be limited to the probe pins or the conductive films mentioned above, and any conductive elements providing the light-emitting diode chip with an electric voltage to enable the light-emitting diode chip to emit light beams is within the protection scope of the present invention.

Referring to FIG. **1**, it is a schematic sectional view showing a detection apparatus for light-emitting diode chip according to a first preferred embodiment of the present invention. As shown in FIG. **1**, the first preferred embodiment of the detection apparatus for light-emitting diode chips of the present invention comprises a substrate **200** with the function of photoelectric conversion and a probing device **100**. The substrate **200** is designed to bear a light-emitting diode chip **10** to be detected. The probing device **100** comprises a power supply **13** and at least two conductive elements. In the first preferred embodiment of the present invention, the conductive elements are probe pins **12**, and two ends of the probe pins **12** are respectively electrically connected to the light-emitting diode chip A and the power supply **13** to enable the light-emitting diode chip A to receive different voltages and to emit a plurality of light beams L**1**. Additionally, as shown in FIG. **1**, the plurality of light beams L**1** is emitted from the light-emitting diode chip A toward the substrate **200** such that the light beams L**1** emitted by the light-emitting diode chip A are converted into an electric signal by the substrate **200**. Besides, in order to collect the light beams from all directions emitted by the light-emitting diode chip more completely and to increase the detection efficiency, a reflective film **40** is optionally disposed on a light-opposing surface of the light-emitting diode chip A to reflect the light beams from other directions emitted by the light-emitting diode chip A, such as light beams or the lateral light beams of one surface opposite to the substrate. The light beams from other directions are reflected by the reflective film **40** toward the substrate **200** in a direction identical to that of the light beams L**1** such that the light beams reflected by the reflective film **40** are converted into an electric signal by the substrate **200**.

Because the luminous efficiency of the light-emitting diode chip is detected by the substrate, which is capable of converting light beams into electric power, the area of the substrate **200** is substantially larger than the light-emitting diode or the array distribution area of the light-emitting diode chips **10** such that the purpose of collecting the light beams emitted by the light-emitting diode chip completely can be achieved. Referring to FIG. **2**A, it is a stereoscopic diagram of the light-emitting diode chip **10**, and in FIG. **2**A, the length of the light-emitting diode chip **10** is L, the width of the light-emitting diode chip **10** is W, and the height of the light-emitting diode chip **10** is H. FIG. **2**B is a schematic sectional view of the light-emitting diode chip **10** taken along a section A-A' of FIG. **2**A, and FIG. **2**C is a sectional view of the light-emitting diode chip **10** taken along a section B-B' of FIG. **2**A. Referring to FIG. **2**B, the biggest light-emitting angle of the light-emitting diode chip **10** toward the substrate **200** is θ, and for the purpose of collecting the plurality of light beams L**1** emitted by the light-emitting diode chip **10** completely being achieved, the length of the substrate **200** should be larger than $[(L+2H \tan(\theta/2)]$. With continued reference to FIG. **2**C, the biggest light-emitting angle of the light-emitting diode chip **10** toward the substrate **200** is θ, wherein $0<\theta<180$, and the width of the substrate **200** should be larger than $[W+2H \tan(\theta/2)]$, therefore the area of the substrate **200** should be larger than $[L+2H \tan(\theta/2)]\times[W+2H \tan(\theta/2)]$ to achieve the purpose of collecting the plurality of light beams emitted by the light-emitting diode chip completely. Besides, as shown in FIG. **1** and FIG. **2**B-**2**C, in the first preferred embodiment of the present invention, a film **30** with adhesive property is disposed between the substrate **200** and the light-emitting diode chips **10** to adhere the light-emitting diode chips **10** onto the substrate **200**. Wherein, the film **30** can be, for example, a white tape, a blue tape or other film with adhesive property, but not limited thereto. Any film, which is capable of adhering the light-emitting diode chip onto the substrate, is within the protection scope of the present invention. Besides, as shown in FIG. **1**, a grip ring **32** can be further disposed on the film **30** to expand the film **30** such that the light-emitting diode chips **10** are arranged immobility on the substrate **200**.

As shown in FIG. **1**, the first preferred embodiment of detection apparatus for light-emitting diode chip of the present invention is suitable for detecting the luminous efficiency of the light-emitting diode chips **10**, the detection procedures are as follows: the light-emitting diode chips **10** are supported by the substrate **200**; and a detection process is performed by the probing device **100**, wherein the power supply **13** of the probing device **100** provides an electric voltage to the light-emitting diode chip A through the probe pins **12** to enable the light-emitting diode chip A to emit the plurality of light beams L**1**. Wherein, the plurality of light beams L**1** are emitted by the light-emitting diode chip A toward the substrate **200** to enable the plurality of light beams L**1** emitted by the light-emitting diode chip A are received by the substrate **200** with the function of photoelectric conversion such that the light beams L**1** are converted into an electric signal by the substrate **200**. A reflective film **40** is optionally disposed on one side of the light-emitting diode chip A opposite to the substrate **200** to reflect the light beams from other direction emitted by the light-emitting diode chip A, and guiding the light beams from other direction emitted by the light-emitting diode chip A toward the substrate **200**, these light beams are converted into an electric signal by the substrate **200**. Then, the electric signal is received by the electronic device **15** such that the luminous efficiency of the light-emitting diode chip A is displayed by the electronic device **15**.

In the detection apparatus for light-emitting diode chip of the present invention, reflective film **40** can be for example an optical reflective film, a metal reflective film, or a film coated with metal compound such as barium sulfate. The reflective film **40** is a film with reflective index larger than 90% within a range of light wavelength from 300 nm to 700 nm. Wherein, the preferred reflection of the reflective film **40** is within a range of visible blue light from 430 nm to 475 nm. Although the reflective film is only depicted in FIG. **1**, but the rest may be deduced by analogy, and the reflective film **40** could be optionally disposed to raise the detection efficiency of the light-emitting diode chip in the second and third preferred embodiments below.

In the detection apparatus for light-emitting diode chip of the present invention, the substrate **200** can be, for example, a solar panel or a photodetector array, and the solar panel can be, for example, an amorphous solar panel or a III-V solar panel, and the photodetector array can be, for example, an array of photoelectric diodes, charge coupled devices, light dependent resistances, quantum optical detectors, photoelectric gates, phototransistors, or photoconductors. However, the substrate **200** with the function of photoelectric conversion is not limited to the solar panel or the photodetector array mentioned above, any substrate performed variations and equivalent modifications is within the protection scope of the present invention.

In the detection apparatus for light-emitting diode chip of the present invention, the conductive elements can further be conductive films. As shown in FIG. **3**, it is a schematic sectional view showing the detection apparatus for light-emitting diode chip according to a second preferred embodiment of the present invention. In the second preferred embodiment of the present invention, the conductive films **14** can be disposed between the substrate **200** and the light-emitting diode chip **10**, and each of the conductive films **14** is electrically insulated with the other conductive films **14** next to the conductive films **14** such that different voltages can be received by the light-emitting diode chip **10** electrically connected to these two conductive films **14** to enable the light-emitting diode chip **10** to emit light beams. Wherein, the material of the conductive films **14** can be, for example, indium tin oxide or indium zinc oxide, but not limited thereto.

Beside, the conductive films **14** can be manufactured by methods such as deposition or etching, but not limited thereto. Users can deposit the conductive material such as indium tin oxide or indium zinc oxide on a membrane such that the conductive films **14** with patterns are formed. Otherwise, the conductive films **14** can be formed by users by etching the conductive material such as indium tin oxide or indium zinc oxide.

As shown in FIG. **3**, the difference between the second preferred embodiment and the first preferred embodiment of the present invention is that the conductive elements of the second preferred embodiment are conductive films **14**. The detection procedures of the second preferred embodiment of the present invention are as follows: the conductive films **14** are disposed on the substrate **200**; the light-emitting diode chips **10** are supported by the conductive films **14**; and a detection process is performed by the probing device **100**, wherein the power supply **13** (not shown in FIG. **3** to enable the figure clean) of the probing device **100** provides an electric voltage to the light-emitting diode chip A through the conductive films **14** to enable the light-emitting diode chip A to emit the plurality of light beams L**1**. Wherein, the plurality of light beams L**1** is emitted from the light-emitting diode chip A toward the substrate **200** to enable the plurality of light beams L**1** emitted by the light-emitting diode chip A is received by the substrate **200** with the function of photoelectric conversion such that the light beams L**1** are converted into an electric signal by the substrate **200**. Besides, the light beams from other directions emitted by the light-emitting diode chip A can be reflected by the reflective film **40** (not shown in FIG. **3** to enable the figure clean) to enable the light beams go toward the substrate **200** such that the light beams reflected by the reflective film **40** are converted into an electric signal by the substrate **200**. Then, the electric signal is received by the electronic device **15** such that the luminous efficiency of the light-emitting diode chip A is displayed by the electronic device **15**.

Referring to FIG. **4**, it is a sectional view showing the detection apparatus for light-emitting diode chip according to the third preferred embodiment of the present invention. As shown in FIG. **4**, the conductive elements are conductive films **14**. In the third preferred embodiment of the present invention, the conductive films **14** are disposed on the light-emitting diode chips **10**, and each of the conductive films **14** is electrically insulated with the other conductive films **14** next to the conductive films **14** such that different voltages can be received by the light-emitting diode chip **10** electrically connected to these two conductive films **14** to enable the light-emitting diode chip **10** to emit light beams. Wherein, the material of the conductive films **14** can be, for example, indium tin oxide or indium zinc oxide, but not limited thereto. Besides, as shown in FIG. **4**, in the third preferred embodiment of the present invention, a film **30** with adhesive property is disposed between the substrate **200** and the light-emitting diode chips **10** to adhere the light-emitting diode chips **10** onto the substrate **200**. Wherein, the film **30** can be, for example, a white tape, a blue tape or other film with adhesive property, but not limited thereto. Any film adaptable to adhere the light-emitting diode chip onto the substrate is within the protection scope of the present invention. Besides, a grip ring **32** (not shown in FIG. **4** to enable the figure clean) could be further disposed on the film **30** to expand the film **30** such that the light-emitting diode chips **10** are arranged fixedly on the substrate **200**.

As shown in FIG. **4**, the difference between the third preferred embodiment and the second preferred embodiment of the present invention is the location of the conductive films **14**. The detection procedures of the third preferred embodiment of the present invention are as follows: the light-emitting diode chips **10** are supported by the substrate **200**; the conductive films **14** are disposed on the light-emitting diode chips **10**; and a detection process is performed by the probing device **100**, wherein the power supply **13** (not shown in FIG. **4** to enable the figure clean) of the probing device **100** provides an electric voltage to the light-emitting diode chip A through the conductive films **14** to enable the light-emitting diode chip A to emit the plurality of light beams L**1**. Wherein, the plurality of light beams L**1** are emitted by the light-emitting diode chip A toward the substrate **200** to enable the plurality of light beams L**1** are received by the substrate **200** with the function of photoelectric conversion such that the light beams L**1** are converted into an electric signal by the substrate **200**. Besides, the light beams from other directions emitted by the light-emitting diode chip A are reflected toward the substrate **200** by the reflective film **40** (not shown in FIG. **4** to enable the figure clean) such that the light beams reflected by the reflective film **40** are converted into an electric signal by the substrate **200**. Then, the electric signal is received by the electronic device **15** such that the luminous efficiency of the light-emitting diode chip A is displayed by the electronic device **15**.

In the present invention, the complication and the detection time that user operating the detection apparatus are reduced by using the substrate, which is capable of converting light beams into electric signal, however, in the detection apparatus for light-emitting diode chip of the present invention, the substrate of the present invention is not limited to the figures of the first, the second, and the third preferred embodiments mentioned above.

In summary, the detection apparatus for light-emitting diode chips of the present invention utilizes a substrate with the function of photoelectric conversion to bear light-emitting diode chips and to detect the luminous efficiency thereof such that the complication and the detection time of detecting the light-emitting diode can be reduced and that the efficiency of detecting the light-emitting diode chips can be increased.

In summation, although the present invention has been described with reference to the foregoing preferred embodiment, it will be understood that the invention is not limited to the details thereof. Various equivalent variations and modifications may still occur to those skilled in this art in view of the teachings of the present invention. Thus, all such variations and equivalent modifications are also embraced within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A detection apparatus for light-emitting diode chip, comprising:

a substrate with the function of photoelectric conversion to bear at least one light-emitting diode chip; and

a probing device, comprising a power supply and at least two conductive elements each having two ends respectively electrically connected to the light-emitting diode chip and the power supply to enable the light-emitting diode chip to emit light beams,

wherein some of the light beams are emitted from the light-emitting diode chip toward the substrate such that the light beams emitted by the light-emitting diode chip are converted into an electric signal by the substrate.

2. The detection apparatus for light-emitting diode chip of claim **1**, wherein the area of the substrate is substantially larger than the array distribution area of the light-emitting diode chips.

3. The detection apparatus for light-emitting diode chip of claim **2**, wherein the area of the substrate is larger than $[L+2H\tan(\theta/2)]\times[W+2H\tan(\theta/2)]$, wherein L is the length of the light-emitting diode chip, W is the width of the light-emitting diode chip, H is the height of the light-emitting diode chip, and θ is the biggest light-emitting angle of the light-emitting diode chip toward the substrate.

4. The detection apparatus for light-emitting diode chip of claim **1**, further comprising a reflective film disposed on one side of the light-emitting diode chip opposite to the substrate.

5. The detection apparatus for light-emitting diode chip of claim **4**, wherein the reflective film is a film with reflective index larger than 90% within a range of light wavelength from 300 nm to 700 nm.

6. The detection apparatus for light-emitting diode chip of claim **5**, wherein the reflective film is a film with reflective index larger than 90% within a range of visible blue light from 430 nm to 475 nm.

7. The detection apparatus for light-emitting diode chip of claim **1**, wherein the conductive elements are probe pins or conductive films.

8. The detection apparatus for light-emitting diode chip of claim **7**, wherein the material of the conductive films is indium tin oxide (ITO) or indium zinc oxide (IZO).

9. The detection apparatus for light-emitting diode chip of claim **7**, wherein the conductive films are disposed between the substrate and the light-emitting diode chip.

10. The detection apparatus for light-emitting diode chip of claim **7**, wherein the conductive films are disposed over the substrate and the light-emitting diode chip.

11. The detection apparatus for light-emitting diode chip of claim **1**, wherein the substrate is a solar panel or a photodetector array.

12. The detection apparatus for light-emitting diode chip of claim **11**, wherein the photodetector array is an array of photoelectric diodes, charge coupled devices (CCDs), quantum optical detectors, photoelectric gates, light dependent resistances, phototransistors, or photoconductors.

13. The detection apparatus for light-emitting diode chip of claim **1**, wherein a film with adhesive property is disposed between the substrate and the light-emitting diode chip, and a grip ring is further disposed on the film to expand the film.

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